

CLAIMS

What is Claimed Is:

1. A micro-actuator assembly for use coupling a slider in a head gimbal assembly, comprising:

5 a planar micro-actuator providing at least one planar micro-actuator arm for coupling to said slider; and

a vertical micro-actuator coupling with said planar micro-actuator arm; wherein said vertical micro-actuator includes a vertical lead pair;

10 wherein said vertical lead pairs receiving an electrical stimulus creates a movement of said slider through said planar micro-actuator arm in a vertical direction; wherein said vertical direction is essentially perpendicular to said rotating disk surface;

wherein said planar micro-actuator arm supports movement through said coupling of said slider in a planar direction; and wherein said planar direction is essentially parallel to said rotating disk surface included in a hard disk drive.

15 2. The apparatus of Claim 1, wherein said planar micro-actuator provides a first planar micro-actuator arm and a second micro-actuator arm, both for coupling to said slider.

20 3. The apparatus of Claim 2, wherein said planar micro-actuator provides said first planar micro-actuator arm and said second micro-actuator arm, both support said movement of said slider in said planar direction.

4. The apparatus of Claim 3, wherein at least one of said first planar micro-actuator arm and said second planar micro-actuator arm includes a piezoelectric device.

25 5. The apparatus of Claim 4, wherein said first planar micro-actuator arm includes a first of said piezoelectric devices;

wherein said second planar micro-actuator arm includes a second of said piezoelectric devices.

6. The apparatus of Claim 5, wherein said first planar micro-actuator arm includes
5 said first piezoelectric device coupling to a first of a slider sleeve containing a first of said coupling to said slider;

wherein said second planar micro-actuator arm includes said second piezoelectric device coupling to a second of said slider sleeves contain a second of said couplings to said slider.

10 7. The apparatus of Claim 3, wherein said first planar micro-actuator arm is electrically coupled in parallel to said second planar micro-actuator arm.

8. The apparatus of Claim 3, wherein said first planar micro-actuator arm is electrically coupled in parallel to said second planar micro-actuator arm to support said
15 movement of said slider in said planar direction when an electrical stimulus is supplied to said electrical coupling of said first planar micro-actuator arm and said second planar micro-actuator arms.

9. The apparatus of Claim 3, wherein said first planar micro-actuator arm is
20 electrically coupled in parallel to said second planar micro-actuator arm.

10. A head gimbal assembly (HGA), comprising said micro-actuator assembly of Claim 1 coupled with said slider using said planar micro-actuator arm and using a coupled flexure to provide said electrical stimulus received by said vertical micro-actuator.
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11. An actuator arm mechanically coupling to said head gimbal assembly of Claim 10.

12. An voice coil actuator assembly, including:
30 at least one of said actuator arms of Claim 11; and

a main flex circuit electrically coupling said flexure included in said actuator arm to provide said electrical stimulus received by said vertical micro-actuator.

13. A hard disk drive, comprising:

5 said voice coil actuator assembly of Claim 12; and
an embedded disk controller printed circuit board electrically coupling with said main flex circuit to further provide said electrical stimulus received by said vertical micro-actuator.

14. A method of making a head gimbal assembly (HGA), comprising the steps of:

10 coupling a micro-actuator assembly with a slider using a planar micro-actuator arm and
using a coupled flexure to provide said electrical stimulus received by a vertical micro-actuator;
wherein said micro-actuator assembly, includes:

a planar micro-actuator providing said planar micro-actuator arm; and

15 said vertical micro-actuator coupled with said planar micro-actuator arm; wherein said
vertical micro-actuator includes a vertical lead pair;

wherein said vertical lead pairs receiving said electrical stimulus creates a movement of
said slider through said planar micro-actuator arm in a vertical direction; wherein said vertical
direction is essentially perpendicular to said rotating disk surface;

20 wherein said planar micro-actuator arm supports movement through said coupling of said
slider in a planar direction; and wherein said planar direction is essentially parallel to said
rotating disk surface included in a hard disk drive.

15. The method of Claim 14, wherein the step coupling said micro-actuator assembly
to said slider is further comprised of the steps of:

25 coupling said slider using said first planar micro-actuator arm;

coupling said slider using said second planar micro-actuator arm.

16. The method of Claim 15, wherein said planar micro-actuator provides said first
planar micro-actuator arm and said second micro-actuator arm, both support said movement of
30 said slider in said planar direction.

17. The method of Claim 16, wherein at least one of said first planar micro-actuator arm and said second planar micro-actuator arm includes a piezoelectric device.

5 18. The method of Claim 17, wherein said first planar micro-actuator arm includes a first of said piezoelectric devices;
wherein said second planar micro-actuator arm includes a second of said piezoelectric devices.

10 19. The method of Claim 18, wherein the step coupling said slider using said first planar micro-actuator arm is further comprised of the step of:
coupling said slider to a first of a slider sleeve; wherein said first piezoelectric device is coupled to said first slider sleeve; and
wherein the step coupling said slider using said second planar micro-actuator arm is
15 further comprised of the step of:
coupling said slider to a second of a slider sleeve; wherein said second piezoelectric device is coupled to said second slider sleeve.

20 20. The method of Claim 16, wherein said first planar micro-actuator arm is electrically coupled in parallel to said second planar micro-actuator arm.

21. The method of Claim 16, wherein said first planar micro-actuator arm is electrically coupled in parallel to said second planar micro-actuator arm to support said movement of said slider in said planar direction when an electrical stimulus is supplied to said
25 electrical coupling of said first planar micro-actuator arm and said second planar micro-actuator arms.

22. The method of Claim 16, wherein said first planar micro-actuator arm is electrically coupled in parallel to said second planar micro-actuator arm.

23. A method of making an actuator arm, comprising the step of mechanically coupling said actuator arm to said head gimbal assembly of Claim 14.

24. Said actuator arm as a product of the process of Claim 23.

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25. A method of making a voice coil actuator assembly, comprising the step of:
electrically a main flex circuit electrically coupling said flexure included in said actuator arm of Claim 23 to provide said electrical stimulus received by said vertical micro-actuator.

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26. Said voice coil actuator assembly as a product of the process of Claim 25.

27. A method of making a hard disk drive, comprising the step of:
electrically coupling an embedded disk controller printed circuit board electrically coupling with said main flex circuit of Claim 25 to further provide said electrical stimulus
15 received by said vertical micro-actuator.

28. Said hard disk drive, as a product of the process of Claim 27.